

# BMD Technology Program Overview



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**Deputy for Technology**

**Ballistic Missile Defense Organization**

**DTIC QUALITY INSPECTED 4**



## TECHNOLOGY PROGRAM GOALS

*Threats And Technology Do Not Stand Still, Therefore*

- Support Missile Defense With Component Technology Improvement

| <u>Increase</u>  | <u>And</u> | <u>Decrease</u>  |
|--|------------|--|
| <ul style="list-style-type: none"><li>• Range</li><li>• Lethality</li><li>• Accuracy</li><li>• Effectiveness</li><li>• Producibility</li></ul> |            | <ul style="list-style-type: none"><li>• Size</li><li>• Cost</li><li>• Weight</li></ul> |

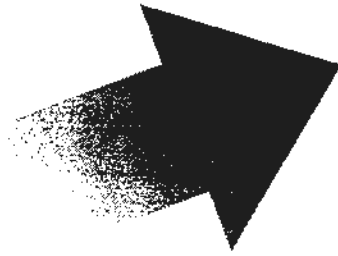
- Pursue Advanced Concepts For Future Responses To An Evolving Threat
  - New Kill Mechanisms
  - High Payoff (Boost-phase Intercept)

**The Key To Improved Performance And Cost Reduction Is Technology Innovation**



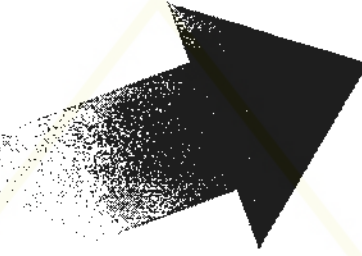
# TOWARDS A BALANCED TECHNOLOGY PROGRAM

## Balanced Technology Investments (6.2, 6.3)



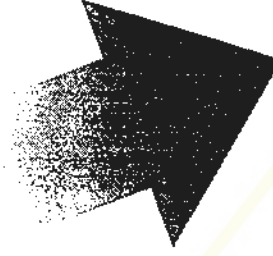
### *Near-term Technology Infusion*

- Cost Reduction
- Risk Reduction
- Shorten Development Timelines



### *Advanced Technologies (Preplanned Product Improvement; New Systems)*

- Countering Advanced Threat
- Reduce Cost / Risk
- Increase Effectiveness
- Support Special Missions



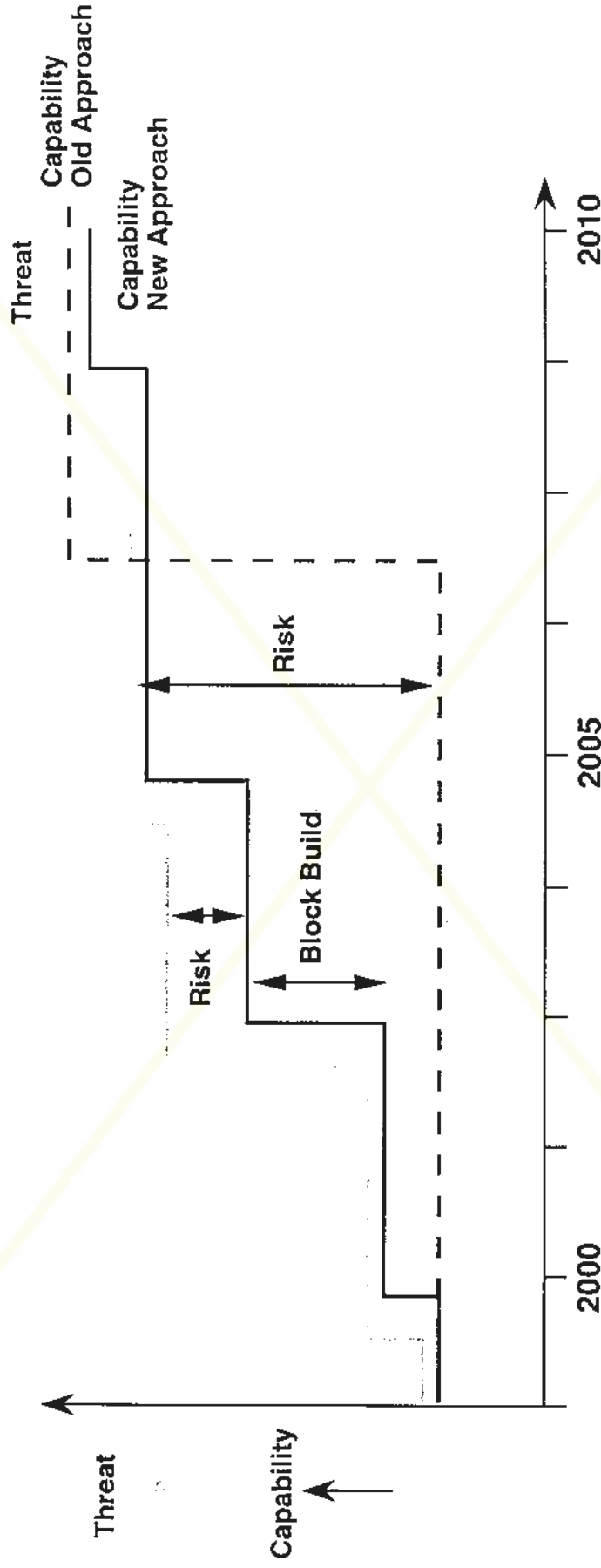
### *Innovative Science And Technology*

- Revolutionary Technologies / Processes
- Future Architecture / Operational Concepts



# OPPORTUNITY - MATCHING ARCHITECTURE TO THE THREAT

## Notional Threat



- Use Continuous Building Block Approach
- Deliver Warfighting Capability Now To Meet Today's Threat
- Lay Out Continuous Implementation / Technology / Funding Road Map To Meet Tomorrow's Threat



## **FACILITATING COST SAVINGS ACROSS THE JOINT MISSION AREA**

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### *Challenges*

- Redundant Capabilities
- Proprietary Technologies

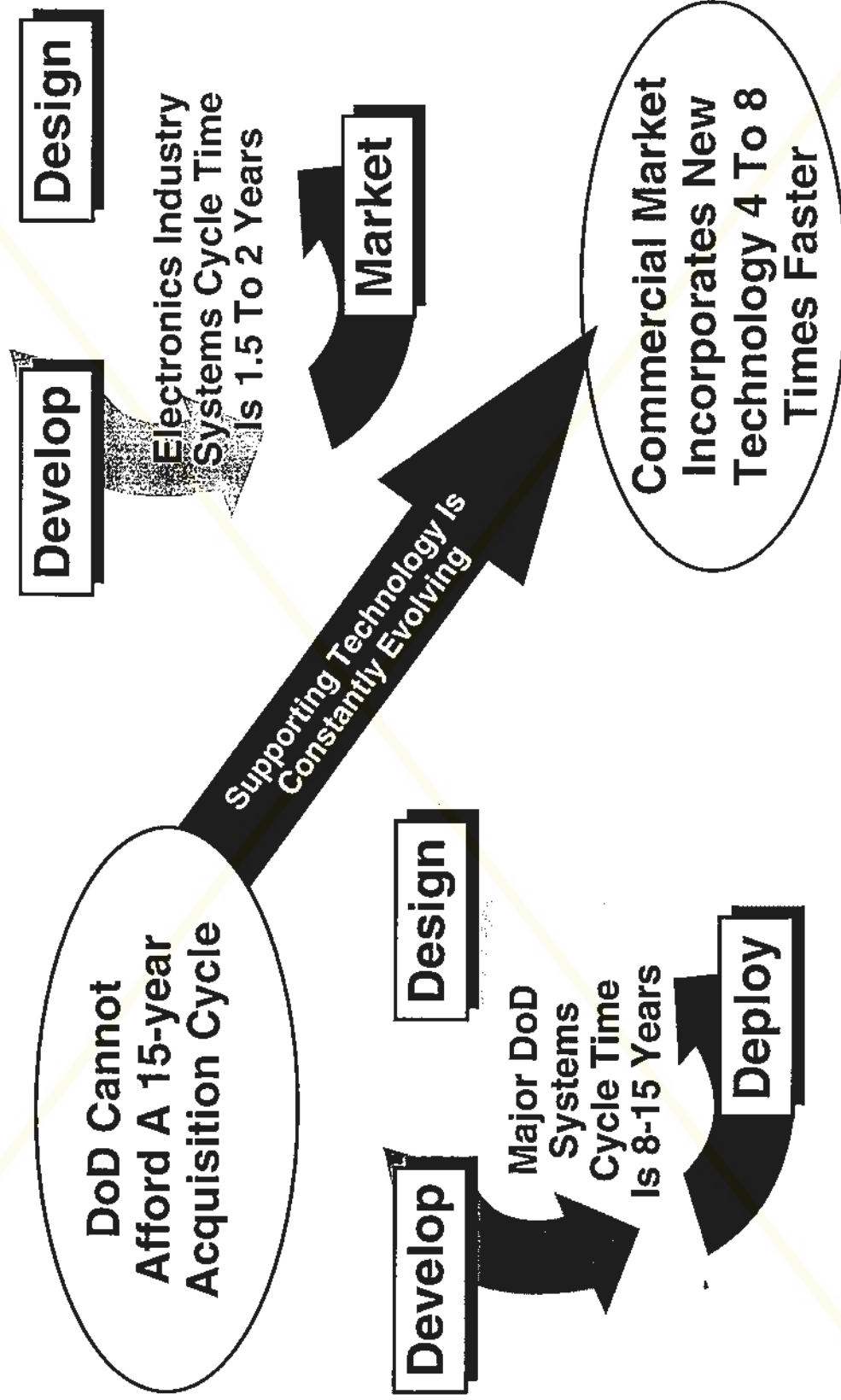
### *Opportunities*

- Define And Implement Open Systems Approach To Hardware Development
  - Plug And Play Modules For Future Architecture / Systems To Lower Cost, Facilitate Interoperability, Reduce Proprietary Solutions
- Rethink The Management Of Risk Reduction Technology Development Programs
  - Focus On Joint Solutions
  - Architecture And System-level As Opposed To Service / Platform Specific





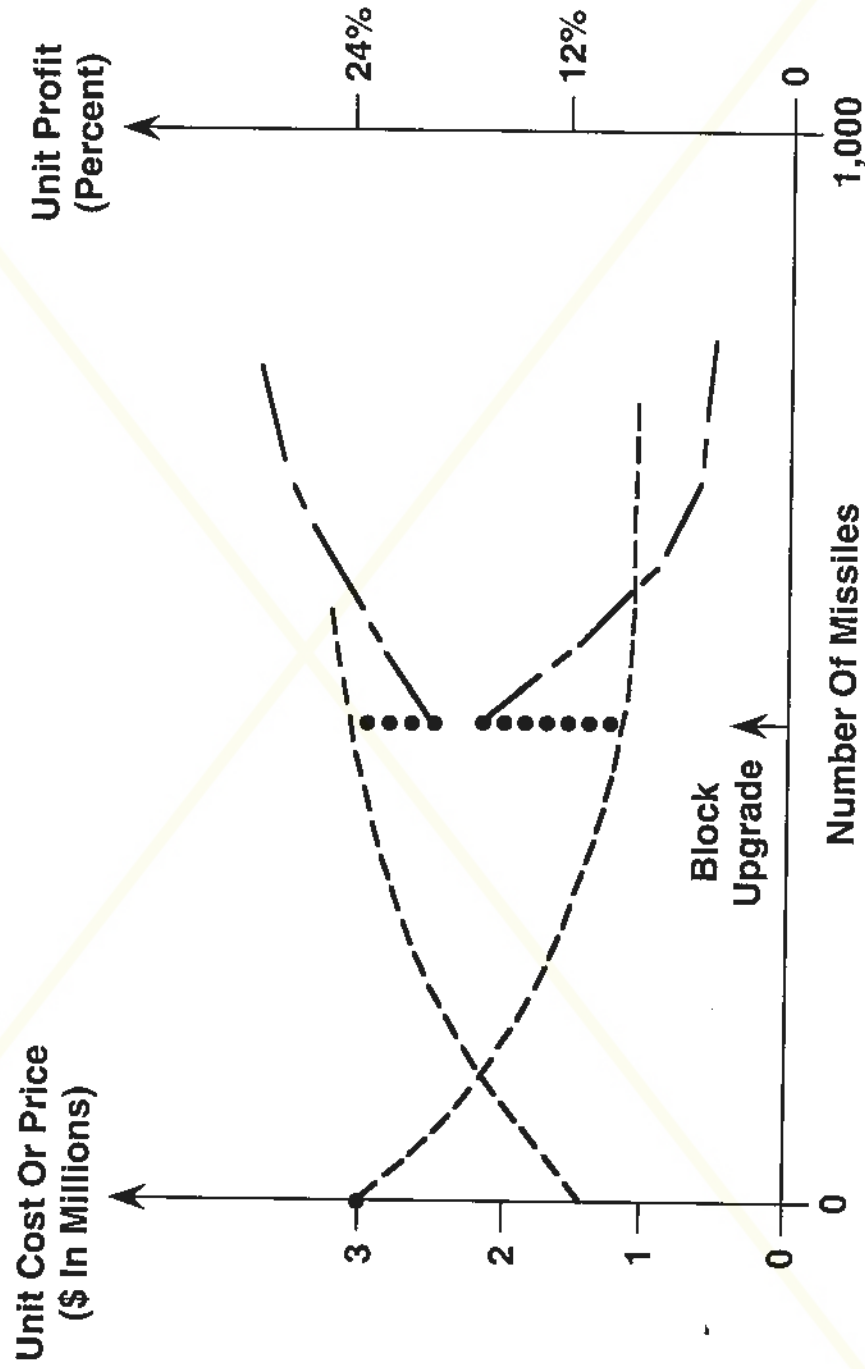
## NEAR-TERM TECHNOLOGY INFUSION





## NEW APPROACH

### *Lean Missile Initiative*





# **PROPOSED NEAR-TERM TECHNOLOGY INFUSION PROGRAMS**

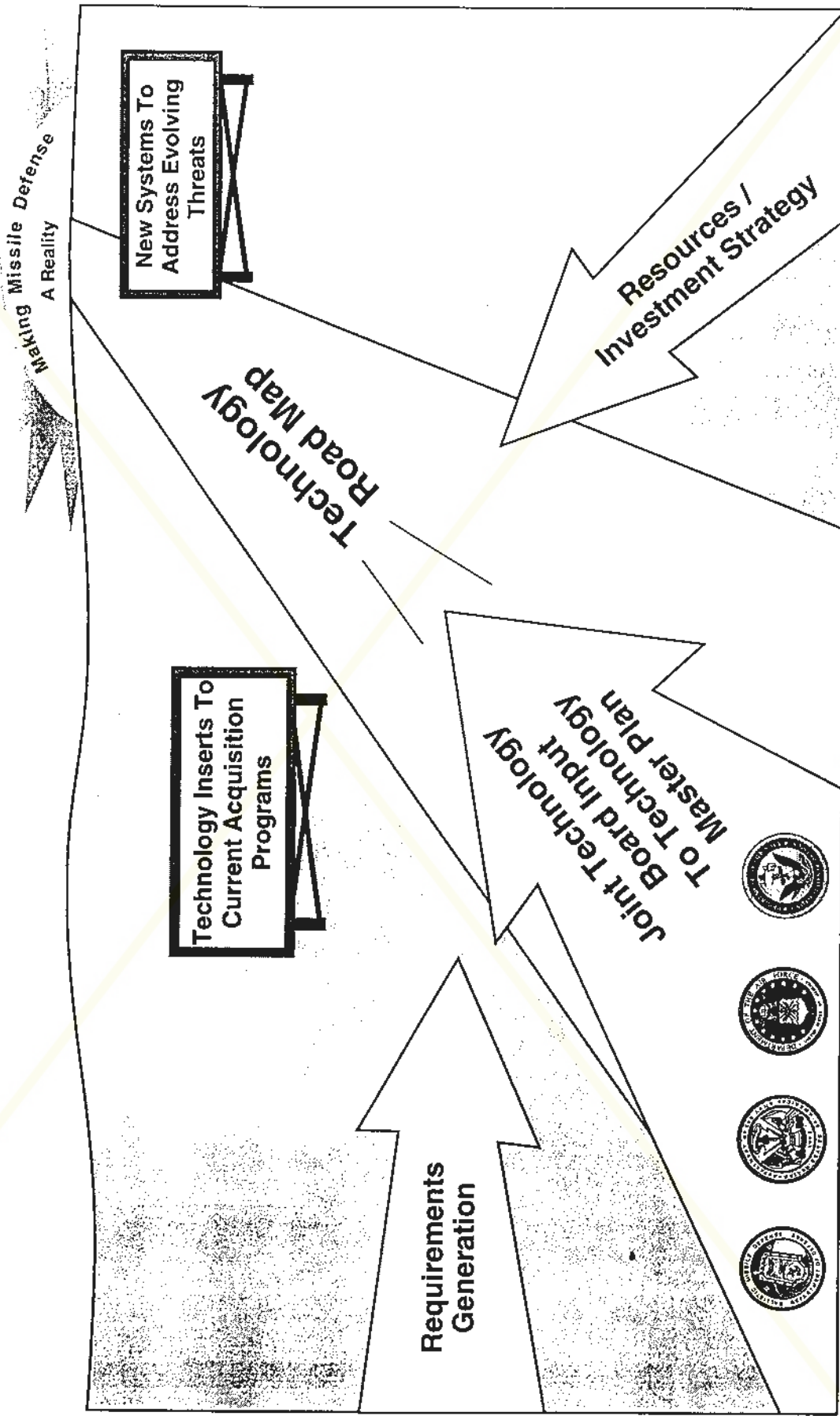
|   |  |
|---|--|
| Materials And Structures<br>(Cooperation With Affordable<br>Multi-Missile Manufacturing<br>Program (AM3)) | <ul style="list-style-type: none"> <li>• <i>Polymer Matrix Composites*</i></li> <li>• Metal Matrix Composites</li> <li>• Advanced Ceramics For Manufacture Of Radomes / Shrouds</li> <li>• IR Windows</li> </ul>   |
| Propulsion  | <ul style="list-style-type: none"> <li>• <i>Component Development / Manufacture For DACS**</i></li> <li>• Energetic Propellants For TMD / NMD Sustainer Engines / DACS</li> </ul>  |
| Sensors<br>(Cooperation With AM3)   | <ul style="list-style-type: none"> <li>• <i>Family Of Interferometric Gyro-based INS Systems For Interceptors*</i></li> <li>• Transmit / Receive Module Cost Reduction</li> <li>• <i>Solid-state Transmitter For PAC-3 / MEADS**</i></li> <li>• Focal Plane Array Producibility</li> <li>• <i>Master Frequency Generator*</i></li> </ul> |
| Signal Processing<br>Electronics<br>(Cooperation With AM3)  | <ul style="list-style-type: none"> <li>• COTS-based Radar Architectures</li> <li>• <i>Advanced Signal Processing For Seekers / Radars / Electro-Optics**</i></li> </ul>  |
| BM/C <sup>3</sup> Hardware  | <ul style="list-style-type: none"> <li>• Large, Ruggedized Displays For BM/C<sup>3</sup> Centers</li> <li>• Asynchronous Transfer Mode Communications</li> <li>• Microwave Power Modules</li> </ul>  |
| Batteries   | <ul style="list-style-type: none"> <li>• Advanced Thermal / Lithium Batteries</li> </ul>   |

\* Ongoing Project \*\* Proposed 1999 Project





# TECHNOLOGY PROGRAM PLANNING





# TECHNOLOGY MASTER PLAN OBJECTIVES

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- Greater Understanding Of The Evolving Threat And Mission Essential / Enabling Capabilities
- Develop Technologies That Keep Pace With The Threat, Reduce MDAP Costs, And Mitigate Risk
- Identify Timelines For Technology Development
- Align Existing Technology Programs, Leverage Service Technology Programs, And Develop New Technology Programs To Meet FoS And NMD Needs
- Determine Level And Timing Of Required Financial Resources

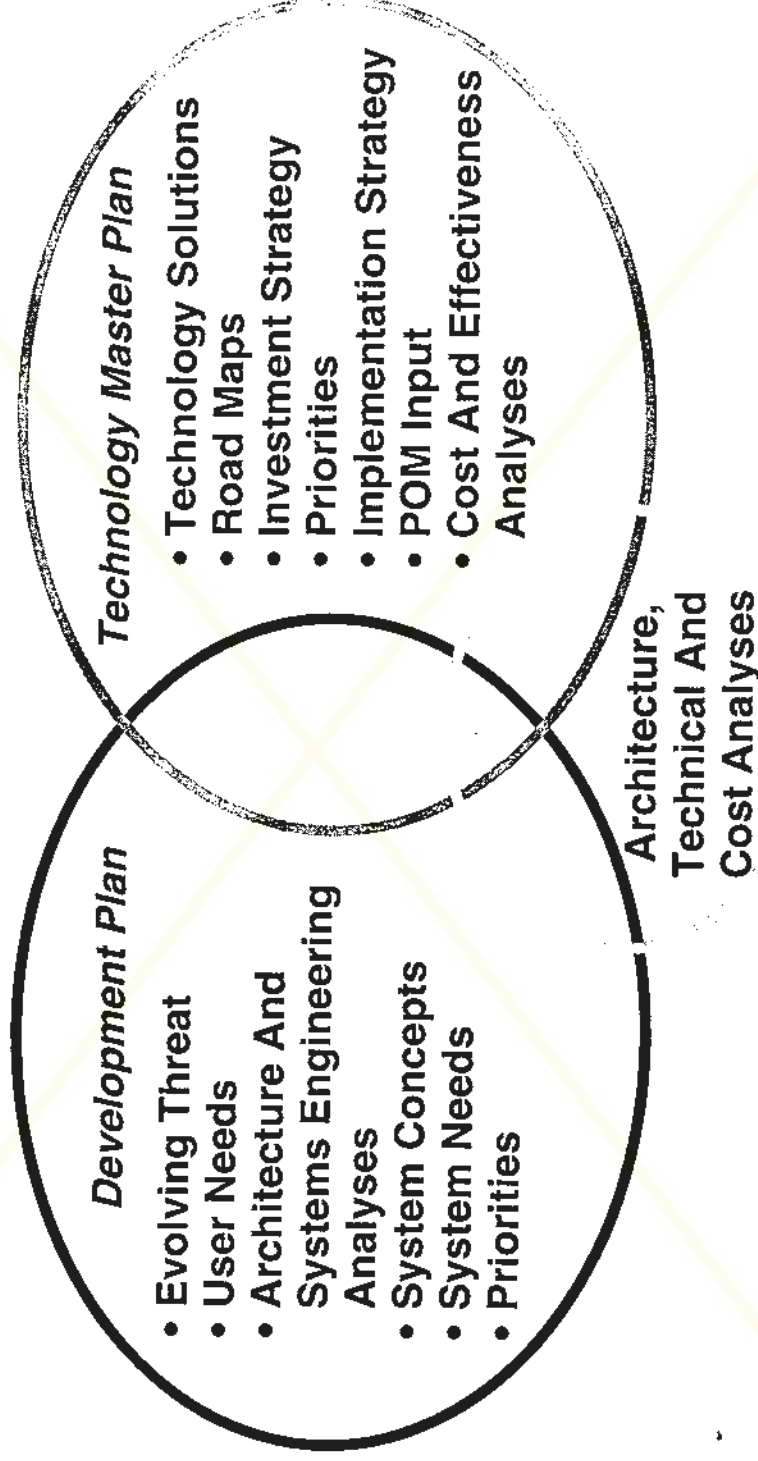
It Is Not Uncommon For People To Equate R&D With The Development Of Hardware, A View Which Is As Limited As It Is Erroneous. The Product Of The R&D Effort Is An Operational Capability. Weapons Hardware Is But One Subsystem Of Operational Capability. This Point Must Be Reemphasized; The Objective Of R&D Is Operational Capability, Not Hardware Per se.

DON RDT&E / Acquisition Management Guide



# BMDO PLANNING FOR TECHNOLOGY INVESTMENT

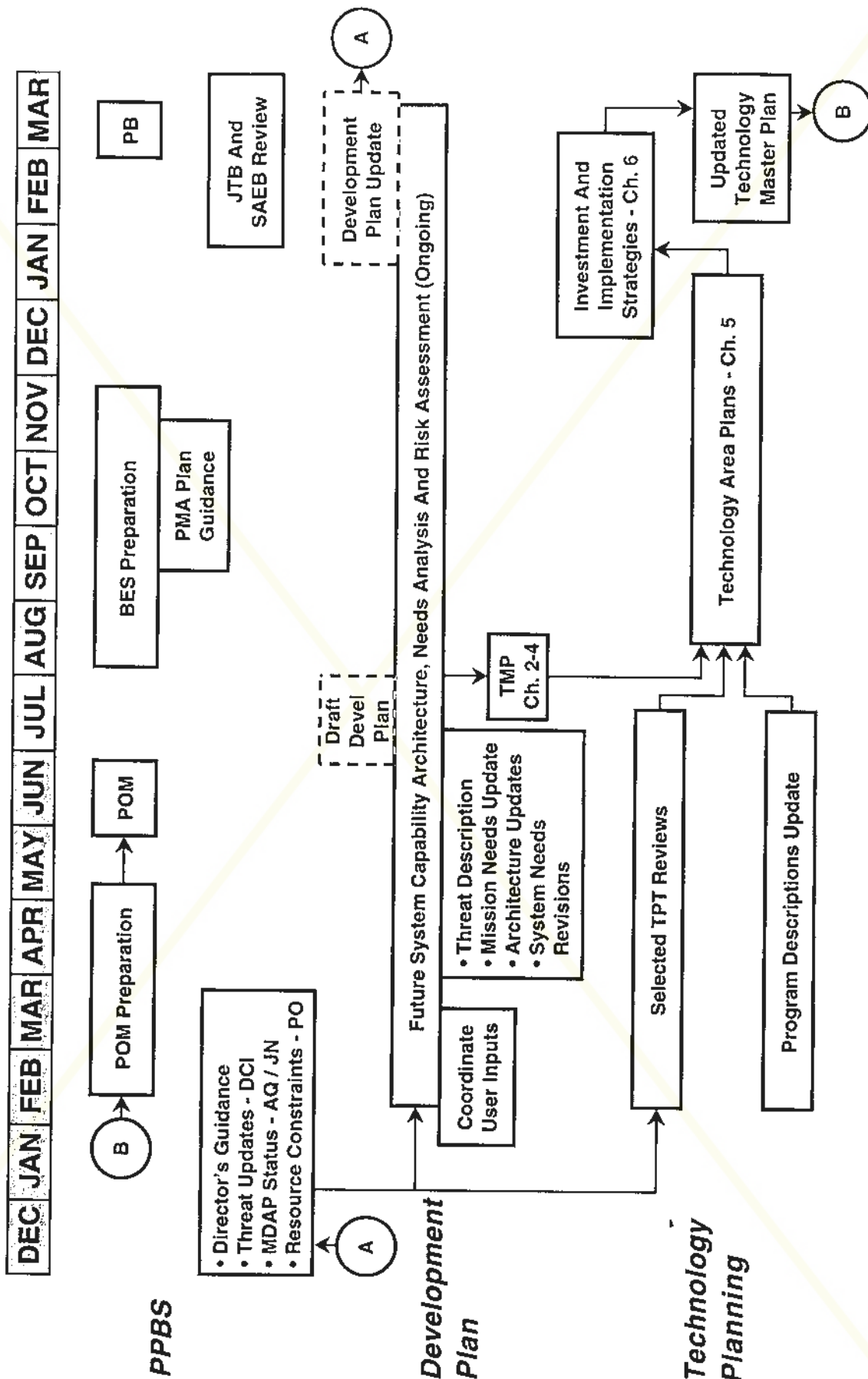
*The Development Planning Process Provides BMDO's System Needs For Technology And Basis For Investment*



**The Technology Master Plan Defines BMDO's Investment And Approach To Obtaining The "Needed" Technology**



# ANNUAL TMP PROCESS







## **CHALLENGE: INVOLVING THE CONTRACTOR COMMUNITY**

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- Government-Industry Open System Applications Group
  - Strategic Partnership With DARPA Affordable Multiple Missile Manufacturing (AM3) Program
  - Initial Meeting Held 18 MAR 98
- Establish Best Practices And Standards For
  - Key Hardware Components
    - Examples: Guidance And Control, T / R Modules, Propulsion, Materials And Structures, Signal Processing Electronics, etc.
  - Grow To Include Key Software Applications (Treat As Components)
    - Examples: BM/C<sup>3</sup>, Hit-To-Kill Guidance, Discrimination, etc.
  - Extend To Include Key Infrastructure Elements
    - Examples: M&S, Testing, Data Analysis And Handling, etc.





## **INDUSTRY REVIEWS**

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- **TMP Coordinator Will Schedule Industry Meetings Through The GOSAG**
  - **BMDO Programs Will Be Presented To Industry**
  - **Two-way Exchange Of Information On Programs, IRAD, And Technology Needs With Each Individually**
  - **TPT Cochairs And Industry Representatives Will Attend**



## TECHNOLOGY PLANNING TEAMS (TPT)

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- TPT Areas
  - Interceptors
  - Surveillance
  - BM/C<sup>4</sup>I\*
  - Directed Energy\*
- Responsibilities
  - Identify Programs That Meet Technology Needs
  - Develop Technology Area Plans
  - Tailor Or Leverage Existing Programs Where Possible, Otherwise Recommend New Starts
  - Produce Technology Road Maps
  - Prioritize Technology Programs

\* Formed 1998



# TECHNOLOGY PROGRAM APPROACH

| Threat   | Stressed BMD Function  | System Need For Technology  | Technology Focus   |
|--|--|---|--|
| <ul style="list-style-type: none"> <li>• Penalds                             <ul style="list-style-type: none"> <li>- Jammers</li> <li>- Flares</li> <li>- LREPs</li> <li>- Aerosols</li> <li>- Coatings</li> <li>- Chaff</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Discrimination</li> <li>• Kill Assessment</li> <li>• Track And Track Accuracy</li> </ul>  | <ul style="list-style-type: none"> <li>• RF / IR Discrimination</li> <li>• Signature Characterization</li> <li>• Multiple Sensor Data Fusion</li> <li>• TOM Generation</li> <li>• High Performance Data / Signal Processing</li> </ul>                              | <ul style="list-style-type: none"> <li>• Integrated Active / Passive Seeker</li> <li>• Multicolor Seeker (IR)</li> <li>• Laser Radar / Interrogator / Imaging Ladar</li> <li>• Discrimination / Sensor Fusing Algorithms</li> <li>• Wave Front Sensing</li> <li>• Wideband Radar Processing</li> <li>• High-power / Efficiency T/R Modules</li> <li>• High-G Divert</li> <li>• BM Logic For Object Sampling</li> </ul>                                       |
| <ul style="list-style-type: none"> <li>• Advanced Submunitions</li> </ul>  | <ul style="list-style-type: none"> <li>• Intercept Timeline</li> </ul>   | <ul style="list-style-type: none"> <li>• Surveillance</li> <li>• Boost Phase Intercept                             <ul style="list-style-type: none"> <li>- Kinetic Energy</li> <li>- Directed Energy</li> </ul> </li> <li>• Multiple Sensor Data Fusion</li> </ul> | <ul style="list-style-type: none"> <li>• Cooled Window</li> <li>• Wide Field Of Regard Seeker</li> <li>• Plume / Hard Body Aim Point</li> <li>• Blended Aero / Divert</li> <li>• Typing</li> <li>• Detection / Background Suppression Algorithms</li> <li>• Wave Front Sensing</li> <li>• Multispectral Sensor Fusion</li> <li>• High-power / Efficiency T/R Modules</li> </ul>  |
| <ul style="list-style-type: none"> <li>• Way Point Navigation</li> <li>• Multi-axis Attacks</li> <li>• Very High-G Maneuver</li> <li>• Reduced RCS (VLO)</li> <li>• Very Low Altitude</li> </ul>   | <ul style="list-style-type: none"> <li>• Lethality</li> <li>• Maneuverability</li> <li>• Minimum Intercept Altitude</li> <li>• Surveillance</li> <li>• Battle Management</li> <li>• Affordability</li> </ul> | <ul style="list-style-type: none"> <li>• Safe High Performance DACS</li> <li>• Traffic Handling</li> <li>• Lower Tier Discrimination</li> <li>• Processing And Algorithms</li> <li>• Reduced Life Cycle Cost</li> </ul>   | <ul style="list-style-type: none"> <li>• High-G Fast Response Divert</li> <li>• Maneuvering Target Algorithms</li> <li>• Wide Field Of Regard Seeker</li> <li>• Fast Frame FPA / On FPA Motion Detector</li> <li>• RF / IR Apertures</li> <li>• Blended Aero / Divert Control</li> <li>• Real-time Data Processing / Fusion</li> <li>• High-power / Efficiency T/R Modules</li> <li>• VLWIR Multiple Quantum Well FPA</li> <li>• Waveform Sensing</li> </ul> |



## **INTERCEPT FOCUS AREAS**

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- **Atmospheric Interceptor Technology (AIT)**
  - Advanced Lower Tier Intercept Technology
  - Endoatmospheric Seekers, Windows, Interceptor Agility, Safe DACS, Optimal Guidance, Estimation Of Target Maneuvers
- **Exoatmospheric Interceptor Technology (EIT)**
  - Advanced Technologies For NMD And TMD Upper Tier
  - Multicolor Focal Plane Arrays, Laser Radar, Advanced Processors, Algorithms
- **Boost Phase Intercept (BPI)**
  - Target State Estimation Sensors And Algorithms, Missile Plume To Hard Body Handover



## **TMP TECHNOLOGY AREAS**

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- **Atmospheric Interceptor Technology (AIT)**
- **Exoatmospheric Interceptor Technology (EIT)**
- **Boost Phase Intercept Technology (BIT)**
- **Advanced Radar Technology (ART)**
- **Advanced Passive Technology (APT)**
- **Advanced Mission Technology (AMT)**
- **BM/C<sup>4</sup>I Advanced Technology (BAT)**
- **Directed Energy Technology (DET)**





# INTERCEPT INTEGRATED TECHNOLOGY PROGRAMS

## Atmospheric Intercept Technology



Advanced GNC Avionics



Ka-band Transmitter



Shroud



Strapdown IR Seeker



Cooled Window



Safe DACS

## Exoatmospheric Intercept Technology

### Component Development

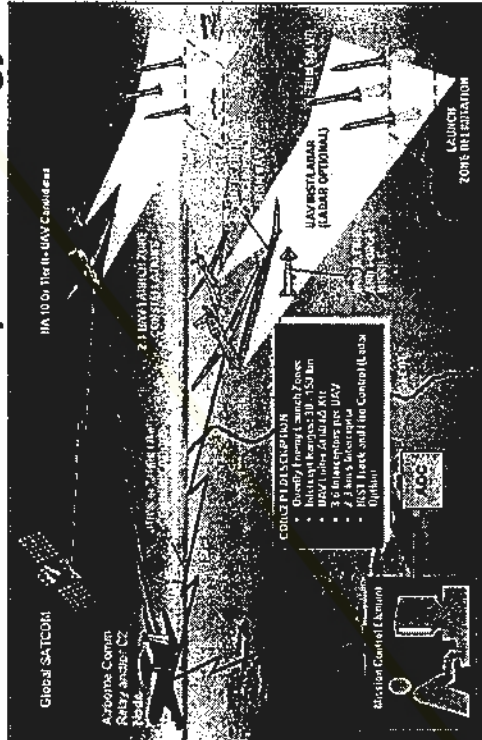


### Ground Testing

Laboratory AMOR ISTE Others

### Flight Testing

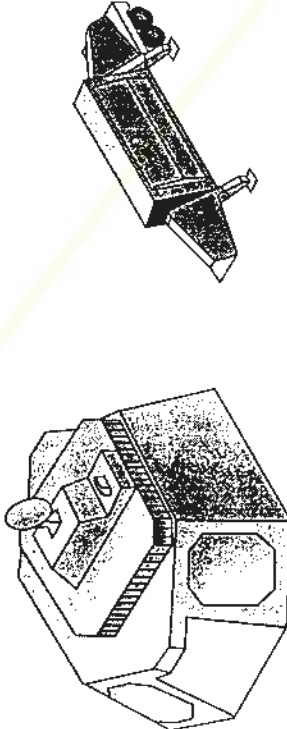
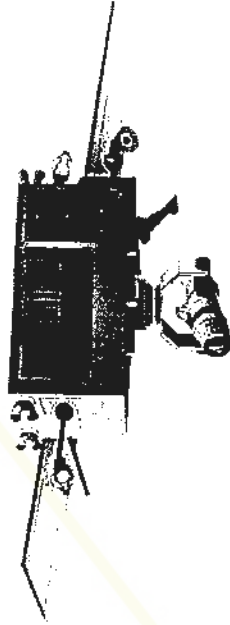
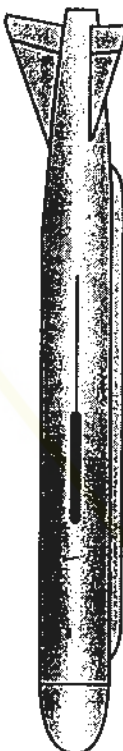
## Boost Phase Intercept Technology



- The BMDO Technology Master Plan (TMP) Is The Foundation For Restructured Intercept Technology Programs
- Intercept Technologies Are Better Tied To MDAP Needs
- New Technologies Will
  - Respond To Evolving Threat
  - Enhance Current MDAP Performance
  - Improve Affordability / Reliability



# SURVEILLANCE INTEGRATED TECHNOLOGY PROGRAMS

|   |   |
|---|---|
| <b>Advanced Radar Technology (ART)</b><br>     | <b>Advanced Passive Technology (APT)</b><br>   |
| <b>Advanced Mission Technology (AMT)</b><br> | <ul style="list-style-type: none"><li>• The BMDO Technology Master Plan (TMP) Is The Foundation For Surveillance Technology Programs</li><li>• Surveillance Technologies Are Directly Tied To MDAP Needs</li><li>• Technology Efforts Will<ul style="list-style-type: none"><li>- Meet Current MDAP Requirements</li><li>- Respond To Evolving Threat</li><li>- Improve Affordability / Reliability</li></ul></li></ul> |



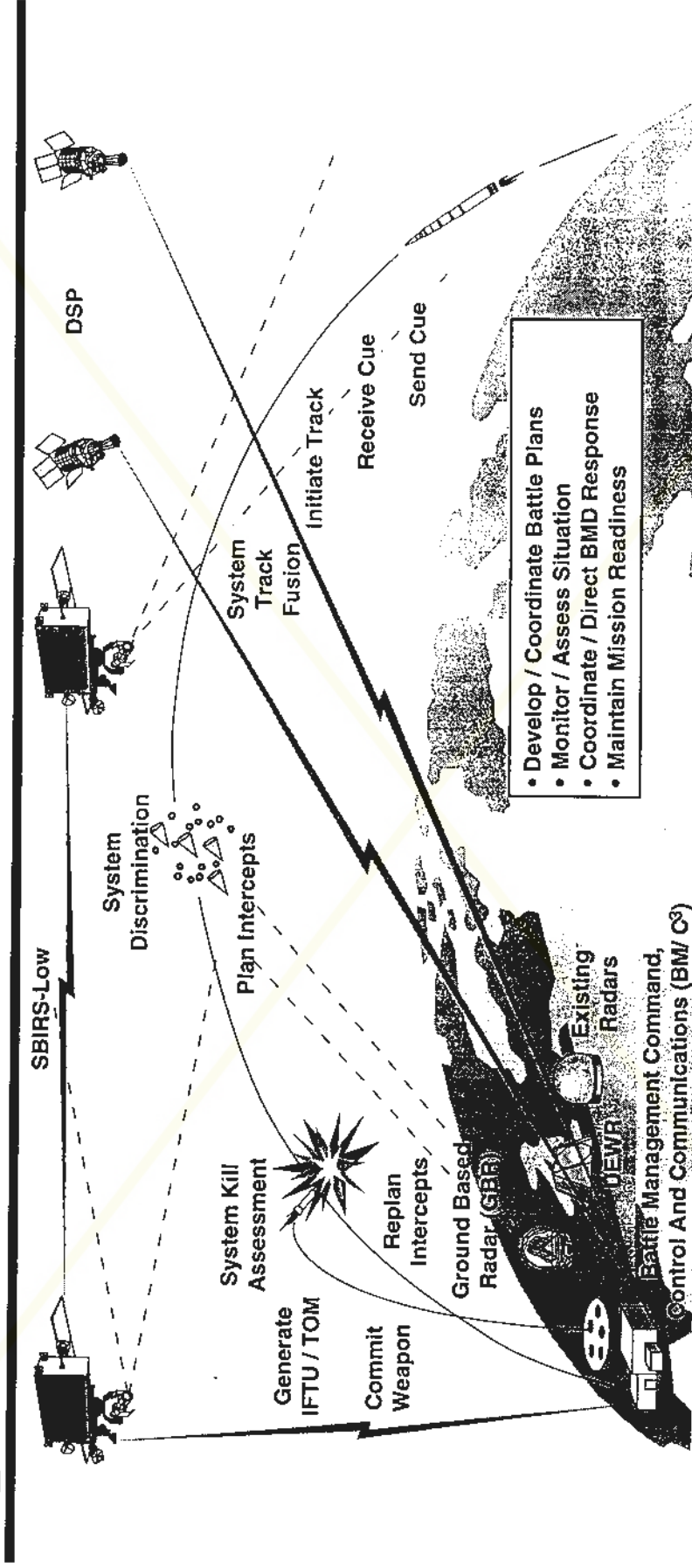
## **SURVEILLANCE FOCUS AREAS**

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- **Advanced Radar Technology (ART)**
  - Increased Power Aperture And Beam Agility, Enhanced Waveform Design
  - Low Cost T / R Modules, Improved Processors, Advanced Algorithms
- **Advanced Passive Technology (APT)**
  - Advanced Components For Satellite Surveillance, Acquisition, Track, Discrimination, Kill Assessment (SATDKA)
  - Improved FPA Uniformity, Longer Wavelengths, Optics Cleaning, Cryocoolers, Radiation Hardened Electronics
- **Advanced Mission Technology (AMT)**
  - SATDKA Functions For Cruise Missile Threat



# BM/C4I ADVANCED TECHNOLOGY (BAT)



## Defense Against Strategic Ballistic Missiles

- The BMDO Technology Master Plan (TMP) Is The Foundation For Restructured BM/C4I Technology Programs
- BM/C4I Technologies Are Tied To MDAP Needs
- New Technologies Will
  - Improve Battle Management In Response To An Evolving NMD / TAMD Threat
  - Enhance Current MDAP Performance And Improve Affordability / Reliability
  - Address Advanced Mission Threat Battle Management





## **BM/C<sup>4</sup>I FOCUS**

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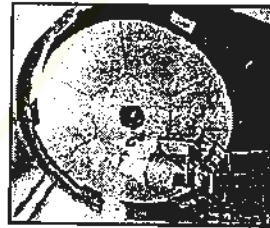
- **BM/C<sup>4</sup>I Advanced Technology (BAT)**
  - **Use Open Systems Standards, Leverage Communications Infrastructure**
  - **Battle Management Technology, Situation Awareness, Kill Assessment, Evaluation Tools**



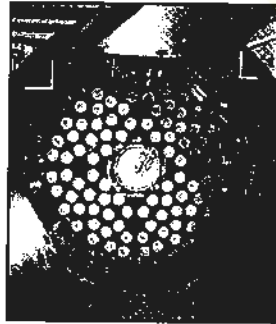


# DIRECTED ENERGY TECHNOLOGY DEVELOPMENT CONCEPT

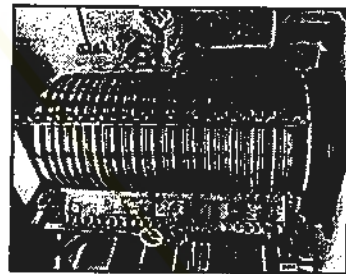
## Demonstrated Technologies



Large Optics  
(LAMP, 1989)



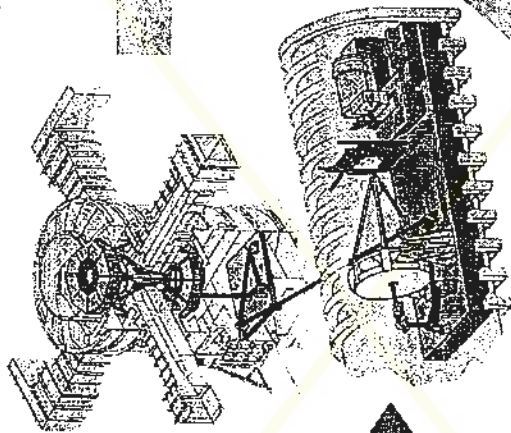
Beam Control  
(LODE, 1987)



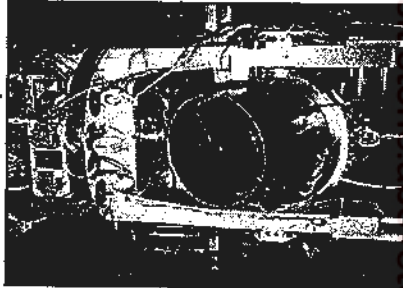
Laser  
(Alpha, 1991)

## Integration

Alpha LAMP Integration (ALI)  
End-to-end Weapon Element Testing

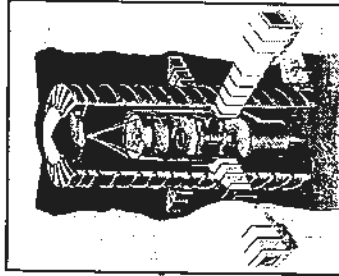


Acquisition Tracking, Pointing  
And Fire Control  
(High Altitude Balloon Experiment (HABE))



## System-level Development

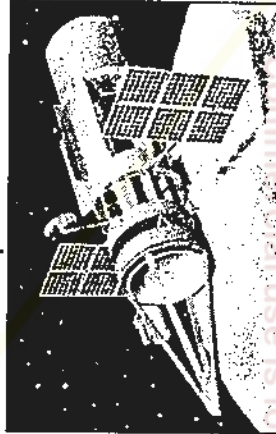
Integrated Ground Demonstrator (IGD)



Integrated Flight Experiment (IFX)



Future Operational SBL





## **DIRECTED ENERGY FOCUS**

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- **Directed Energy Technology (DET)**
  - **Integrated Technology For Space Based Laser Integrated Flight Experiment (IFX)**
  - **Precision Pointing, Waveform Sensing Adaptive Optics, Advanced Beam Generation**



## **RESEARCH / EXPLORATORY DEVELOPMENT (IS&T, SBIR)**

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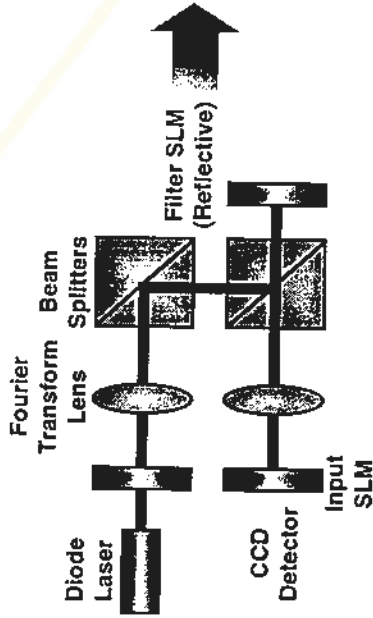
- **Innovative Science And Technology (IS&T)**
  - **Research And Exploratory Development Targeting Breakthrough Technologies For Ballistic Missile Defense**
  - **Core R&D Program In Sensing, Directed / Kinetic Energy, Materials, Propulsion, Power, And Information Processing**
- **Small Business Innovative Research (SBIR)**
  - **Mandated Percentage Of Extramural R&D**



# INNOVATIVE RESEARCH – HIGH RISK TECHNOLOGY FOR BMDO'S FUTURE

## Development Of Grayscale Optical Correlator

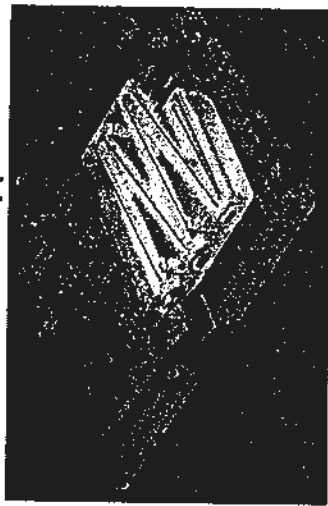
Optical Correlator  
Schematic



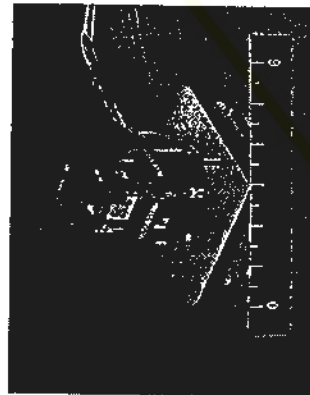
BMDO Funded Camcorder-sized  
Grayscale Optical Correlator  
JPL – 1998



Matchbox-sized Optical  
Correlator To Be Delivered For  
DoD And NASA Applications

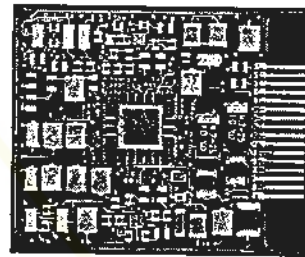


## 1998 INS / GPS

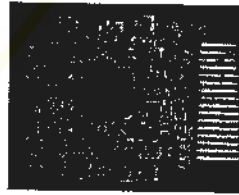


6-dof ISA  
3 cu in

## MEMS Gyro Instrument Progression



1997  
0.47 cu in  
Commercial Gyro



1998  
0.35 cu in  
High Performance Gyro

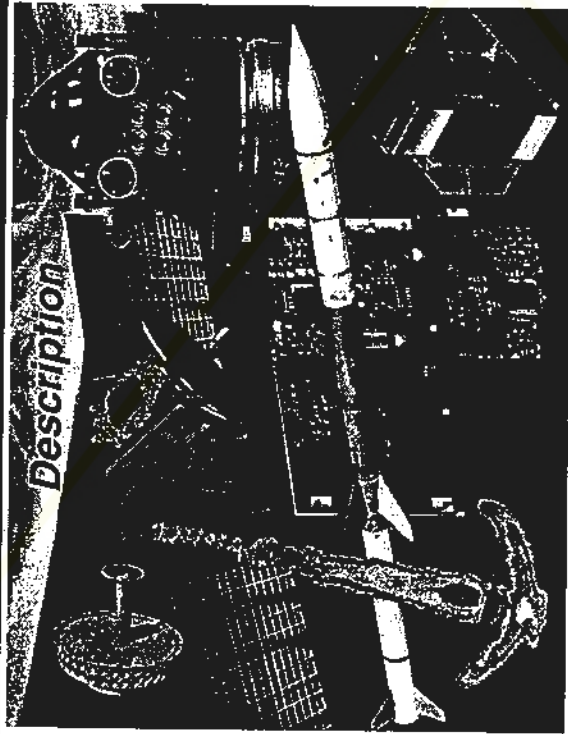


1999  
0.17 cu in  
High Performance Gyro





# INNOVATIVE SCIENCE AND TECHNOLOGY



## Issues

- Rapid, Drastic Funding Reductions Are Devastating To Innovative Research And Will Limit BMDO's Ability To Meet Advanced Threats
- Current Program Supports Several Key Technologies And Closes Out Many Others, No Significant New Starts
- Funding Reductions In Opposition With Recent Congressional Language

## Benefits / Applications

- Keeps BMDO On "Cutting Edge" Of Technology, BMDO's Investment In The Future
- Identifies And Develops Key New Technologies To Meet Emerging And Far-term Threats
- Provides Innovative Upgrades For Existing Systems
- MDAP Relevance: Generic High Payoff Technologies For TMD/NMD/CMD Applications

## Budget / Selected Products FY 00 PB (TY \$M)

| FY 95   | FY 96   | FY 97   | FY 98   | FY 99   | FY 00  |
|---------|---------|---------|---------|---------|--------|
| \$80.00 | \$65.00 | \$52.00 | \$52.82 | \$22.98 | \$7.86 |

- SCARLET Arrays And Hall Thrusters For SBIRS-class Programs
- Advanced Thermal Batteries For THAAD
- Lasercom For Rapid, Secure Communications
- Miniature Interceptor Technology For Advanced Submunitions
- Advanced Sensors / Sugar Cube Processor / Neural Net Algorithms For BMD / CMD ATR





## IMPLEMENTATION STRATEGY

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- Based On Director's Guidance To Allocate 10% (Minimum) – 12% (Goal) Of BMDO Total Obligational Authority To Technology Development
  - Includes Set-asides (e.g., SBL Readiness Demonstrator, SBIR)
- Consistent With Technology Priorities
  - Solution Or Mitigation Of A Critical Challenge
  - Cost Reduction
  - Multiple Potential Applications
  - Breakthrough Technologies



## **A NEW APPROACH**

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- **Building Consensus Requires New Approach**
  - **Relate Technology Programs To Military Deficiencies, Technology Needs And Operational Capability**
  - **Establish Process For Corporate Participation And Decision Making**
  - **Develop A Product To Guide And Coordinate Missile Defense Technology Programs**
- **The Technology Master Plan Process Incorporates This Paradigm Shift**



## SUMMARY

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- **BMDO TMP Is The Vehicle For Implementing Director's Guidance For Technology**
  - **Maintain U.S. Technical Superiority In Missile Defense**
  - **Relate BMDO Technology To MDAP Needs And Operational Capabilities**
  - **Allocate A Goal Of 12% Of TOA, But Not Less Than 10% For BMDO Technology Program**
  - **Maximize Participation Of Missile Defense Community In BMDO Technology Program**